

# Final Report

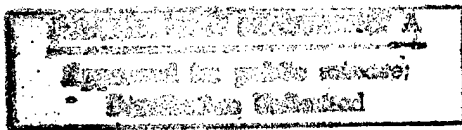
## *Satellite/Terrestrial Communication Network Evaluation With Computer-Aided Workstation Tools*

**Principal Investigator:** Dr. Rodger E. Ziemer  
**Co-Investigators:** Drs. Mark A. Wickert, C.-J. (Charlie) Wang, Edward Chow

**Grant Number** N00014-920J01761/P00004

**R&T No.** s400012srb11

**Performance Period:** 1 July 95 – 30 June 98



August 1998

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**Abstract:** *Research has been performed on satellite and terrestrial networks. The work was broken down into five tasks: Network, channel, and modem models; Investigation of decentralized routing/restoration algorithms under dynamic network conditions; Characterization of throughput and error performance; Applicability of various adaptive and diversity approaches; Study connectivity and flow control strategies appropriate for networks of networks with mobile nodes. The output of the grant is in the form of several publications in national and international conference proceedings, archival journals, and masters and Ph. D. theses. Several specialized pieces of software were developed and are briefly described in Appendix A.*

## I. Introduction

### A. Objective

The objective of this research project was to use analysis and computer simulation to investigate problems associated with satellite and terrestrial communications networks. It was anticipated at the inception of the project that extensive use would be made of a previously developed workstation simulation tool called SATLINK, in conjunction with parallel computation. Because of the advances in desk top computer capacity and software for simulation and computation, we found it more expedient to develop several pieces of special purpose software. Some of these are summarized in Appendix A. Others are described in several Ph. D. dissertations written during the course of the project [53-64].

### B. Context

As mentioned above, the research carried out under the present grant rested on previous research carried out under BMDO/ONR (formerly SDIO) funded research grants. In particular, these were: (1) "Analysis of Multi-hop, Multi-user Spread Spectrum Communications Systems," 1986-88; (2) "Performance Analysis and Optimization of Dynamic Multi-hop Multi-user Networks in Hostile Environments," 1988-1990 and continuation 1990-1992; (3) "Multiple-Processor Workstation Evaluation of Dynamic Multihop Multi-user Satellite Networks with Applications," 1992-1995; (4) the current grant "Satellite/Terrestrial Communication Network Evaluation with Computer-Aided Workstation Tools," 1995-1998 with an accompanying AASERT grant.

### C. Tasks

The work in the subject grant was broken down into the following tasks:

- 1) Network, channel, and modem models;
- 2) Investigation of decentralized routing/restoration algorithms under dynamic network conditions;
- 3) Characterization of throughput and error performance;
- 4) Applicability of various adaptive and diversity approaches;
- 5) Study connectivity and flow control strategies appropriate for networks of networks

with mobile nodes.

#### D. Personnel Involved

At various times throughout the grant activity, four faculty members were involved, with a maximum of three being involved simultaneously. They were Drs. Edward Chow, Charlie Wang, Mark Wickert, and Rodger Ziemer; Drs. Chow and Wang are oriented more towards networking and Drs. Wickert and Ziemer are mainly concerned with physical layer issues. Dr. Chow is in the Computer Science Department, and Drs. Wang, Wickert, and Ziemer are in the Electrical and Computer Engineering Department. With the level of funding in the current grant, along with the AASERT grant, a maximum of three graduate students could be funded in half-time positions, with some additional graduate students being funded sporadically at less than half-time rates. The graduate student funded under the AASERT grant was Mark Petzold. Adrian Boariu was funded as a half-time Ph. D. student under the umbrella grant, with the second position being held by M.S. students William Guilfoyle and Keith Kressin [62-63]. Boariu and Petzold are expected to complete their dissertations in Dec. 1998 [60-61]. During the last year of the grant, Ph. D. student David Harvatin occupied the second position (formerly an M. S. student funded under another grant). Since the work on the current grant related closely with work performed under previous grant, the dissertations of several of the Ph. D. students supported under it are listed [53-55]. Finally, several dissertations of students paid on a sporadic basis from the grant are listed [56-58] along with a Ph. D. student (Navy Commander) who was a faculty member at the Air Force Academy who did work closely aligned with the grant [59].

## II. Grant Management

### A. Supervision

Overall grant management was provided by Dr. Ziemer with the other faculty involved directing research in their particular areas of interest.

### B. Weekly Meetings and Seminar Series

Weekly meetings were held throughout the grant period. A very brief time was spent at each meeting on administrative and organizational points; the major portion of the one-hour meeting time was devoted to various faculty and graduate students involved presenting seminars on their current research interests or activities. A complete collection of the semester-by-semester announcements for these seminars is given in Appendix B.

### C. Visiting Faculty

It will be noted that several seminars were given by visiting faculty. While not directly involved in the grant, these faculty members enriched the research environment and are therefore listed here. They are: Dr. Paul Cotae, Technical University of Iasi, Romania, Aug. '94 - May '95 as a

Fulbright Fellow and June '95 – Aug. '97 as a part-time faculty member; Dr. Simona Halunga, University Polytechnica Bucharest, Romania, Sept. 1997 – present (visiting associate professor); Dr. Vasile Buzuloiu, University Polytechnica Bucharest, Romania, Oct. '97 (visiting lecturer); Dr. Will Ebel, Mississippi State University, Dec. 3-4, 1996, May 7-10, 1997 (turbo coding expert).

### III. Output

#### A. Papers Related to Tasks

The tasks into which the research was organized are repeated below along with papers produced by personnel supported or doing research related to the project:

- 1) Network, channel, and modem models [14, 16-17, 26, 28, 29, 46-48];
- 2) Investigation of decentralized routing/restoration algorithms under dynamic network conditions [12-13, 19, 24, 26, 31];
- 3) Characterization of throughput and error performance [2, 6, 11, 14-15, 20-21, 23, 26, 32-33, 38, 49];
- 4) Applicability of various adaptive and diversity approaches [3-5, 7-9, 14, 26-27, 30, 34-35, 37, 39-42, 44-46, 51, 52];
- 5) Study connectivity and flow control strategies appropriate for networks of networks with mobile nodes [1, 10, 14, 18, 23, 26].

#### B. Additional Output

Several books and chapters in books not directly related to the research were produced [65-79]. In some of the prefaces of the books, ONR support was acknowledged.

### IV. Conclusion

The productivity under the grant is considered to be excellent. Summarized in the table below are conference publications, journal publications, masters theses, Ph. D. dissertations, book chapters, and books produced under the six years of the grant with its continuation (1992-1998).

<i>Item</i>	<i>Number</i>
Conference publications	41
Journal publications	12
Masters theses	3
Ph. D. dissertations	9
Book chapters	11
Books	4

## Appendix A

### *Computer-Aided Communications Analysis and Design Programs*

#### **Programs written by Mark Petzold:**

##### MATLAB programs:

**Mcsim.m:** Script file simulates multicarrier modulation. Capable of BPSK and DPSK modulation, including both optimum DPSK demodulators and delay and multiply. Capable of spreading each carrier, and repetition coding bits. Error correction coding can be applied in this simulation.

**Viterbi.m:** Basic Viterbi algorithm for convolutional decoding. Outputs all data after the algorithm is finished, rather than using a sliding window to output.

**Mapdecode.m** and **mapdecodellr.m:** Maximum *a posteriori* algorithms for decoding convolutional codes, based on Bahl, Cocke, Jelinek and Raviv algorithm<sup>1</sup>. Can be used in iterative decoding schemes to decode turbo codes and interleaved serial concatenated codes.

**Nrcc.m** and **rcc.m:** Non-recursive and recursive convolutional encoders.

**Printlv.m:** Pseudo-random interleaver generator, which uses an algorithm described by Dunscombe and Piper<sup>2</sup> and an overall interleaver strategy described by Divsalar and Pollara<sup>3</sup>.

**Trellis.m** and **trelliscc.m:** Programs for finding the trellis structure of recursive and non-recursive convolutional codes. The output of these programs is used in the decoders.

**Tc.m:** Turbo code simulation. Fading can be added. Uses some of the functions listed above.

**Iscccsim.m:** Interleaved serial concatenated convolutional code simulation. Fading can be added. Uses some of the functions listed above.

##### C++ programs:

**Vector.cpp:** Data class, which allows vectors to be used and manipulated easily in C++ programs. Key operations have been overridden to allow for easy use.

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<sup>1</sup>L. R. Bahl, J. Cocke, F. Jelinek, and J. Raviv, "Optimal Decoding of Linear Codes for Minimum Symbol Error Rate," *IEEE Transactions on Information Theory*, pp. 284-287, March 1974.

<sup>2</sup>E. Dunscombe and F. C. Piper, "Optimal Interleaving Scheme for Convolutional Coding," *Electronics Letters*, vol. 25, no. 22, pp. 1517-1518, 26 Oct. 1989.

<sup>3</sup>D. Divsalar and F. Pollara, "Turbo Codes for PCS Applications," *Proceedings of ICC'95*, Seattle, pp54-59, June, 1995.

**Matrix.cpp:** Data class, which allows matrices to be used and manipulated easily in C++. Key operations have been overridden to allow for easy use.

**Poly.cpp:** Data class, which allows polynomials to be used and manipulated easily in C++.

**Ccweights.cpp:** Program, which finds weight structure of convolutional codes over certain sized blocks. This information is used in finding the theoretical performance of turbo codes. Uses algorithm proposed by Rowitch and Milstein<sup>4</sup>

**Distspec.cpp:** Program to find the weight structure of convolutional codes based on the algorithm proposed by Rouanne and Costello<sup>5</sup>

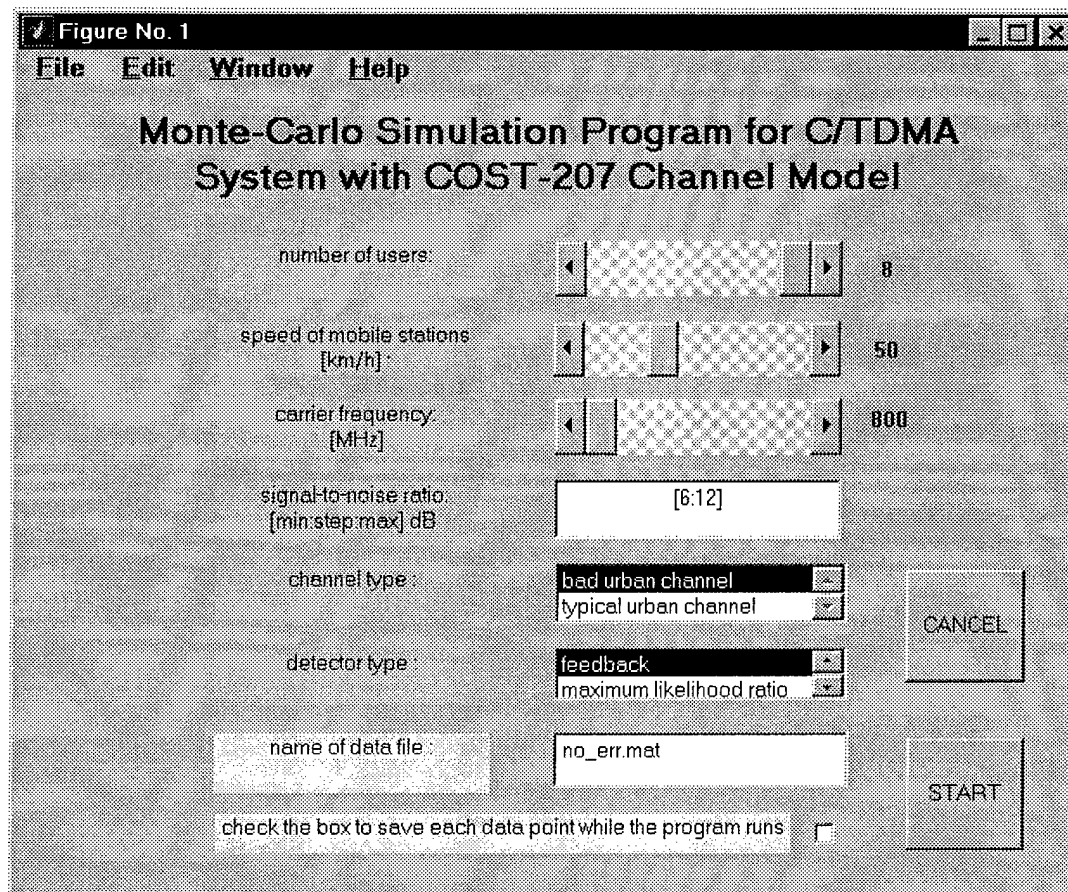
**Programs written by Adrian Boariu (all MATLAB):**

- **start\_sync.m:** Monte-Carlo simulation for C/TDMA system with COST-207 channel model
  - The C/TDMA system is a synchronous code division multiple access (CDMA). We have implemented the system described in FRAMES standard that can be the future standard for the third generation of personal communications system.
  - The channel models implemented are for bad and typical urban cases as they are described in COST-207.
  - We have implemented three different powerful detector types: feedback detector, maximum likelihood ratio detector and turbo detector. The detection methods are based on original ideas. In all cases we have assumed perfect knowledge of channel impulse responses for all users.

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<sup>4</sup> D. N. Rowitch and L. B. Milstein, "A Novel Algorithm for the Evaluation of Transfer Function Bounds on the Performance of Turbo Codes," submitted to *IEEE Trans. Inform. Theory*, Aug. 1997.

<sup>5</sup> M. Rouanne and D. J. Costello, "An Algorithm for Computing the Distance Spectrum of Trellis Codes," *IEEE JSAC*, vol. 7, no. 6, pp. 929-940, Aug. 1989.



- **low\_BER\_sync.m:** Lower bound for bit error probability (BEP) for the C/TDMA system with COST-207 channel model
  - Providing the program with the spreading codes of each user employed in the previous program, we can compute the theoretical lower bound of the BEP. This program is very useful to see how far the simulation curves are from optimum.
- **prog01\_syncwb.m:** Monte-Carlo simulation for wideband CDMA system with all users having the same spreading factor (SF)
  - This system is not very well defined at this time (see the FRAMES standard). We have assumed again a synchronous CDMA system. The particularity of this system is that the users can have different SF. Actually, only the case when all users have the same SF is implemented.
  - The channel model employed is for urban case, described in RACE-2020 final report on the propagation model.
  - We have implemented two different powerful detector types: feedback detector, and turbo detector. For this system we think that the maximum likelihood ratio detector is very hard to be practically implemented. The detection methods are based on original ideas. In all cases we have assumed perfect knowledge of channel impulse responses for all users.
- **low\_BER\_syncwb.m:** Lower bound for bit error probability (BEP) for the wideband CDMA system
  - If the spreading codes for each user employed in the previous program is known, the program

computes the theoretical lower bound of the BEP. This program is very useful to see how far the simulation curves are from optimum.

- **generator.m:** Generator of extended S(1) family spreading codes for the wideband CDMA system
  - The spreading codes have a tremendous influence over the system performance. Low auto- and cross-correlation values of the spreading codes are needed in order to have good performance of the system. Such a spreading code family that suits this purpose is S(1) family. The program generates this family of spreading codes.

**Programs written by David Harvatin (all MATLAB programs):**

**MCM.m:** Simulate OFDM performance in doubly spread channel. User specifies number of carriers, Doppler spread, and number of delay spread paths. Offers options for pilot estimation and ideal channel impulse response compensation. Measures bit error rate and symbol error rate for any of M-ary QAM, PSK, or DPSK.

**BIBD.m:** Measure the critical parameters of BIB designs. Measures number of distinct elements, number of distinct blocks, number of times each element appears in different blocks, number of distinct elements per block, number of times unordered pairs of elements occur in each block, number of intersecting blocks, and number of nonintersecting blocks.

**MTFSKSIM.m:** Simulate multi-tone FSK performance using BIB designs to select the tones. Simulates either Gaussian or flat-fading Rayleigh channel and uses noncoherent (square-law) combining.



## **Appendix B**

### *Weekly Seminar Series Topics*

# **COMMUNICATIONS AND SIGNAL PROCESSING SEMINARS**

**SUMMER SEMESTER, 1998**

**Wednesdays at 11:00**

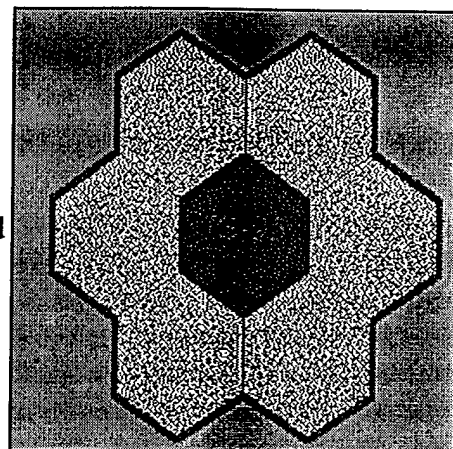
**Room EN239**

- June 17:     Adrian Boariu, "On Access Codes for Wideband CDMA"
- July 1:       Mark Petzold, "Multicarrier SS Performance in Fading Channels with Serial  
Concatenated Convolutional Coding"
- July 15:      Mike Radermacher, "Gauss-Chebyshev Quadrature Integration for Digital  
Communication System Evaluation"
- July 29:      Dave Harvatin, "Steiner Codes and Their Applications"

# Graduate Research Seminars

## Spring Semester 1998

The following seminars will be presented by graduate students and faculty members in room EN 177 in the Engineering and Applied Science Building on the UCCS campus. Ongoing research and dissertation topics in the fields of *communications* and *signal processing* will be discussed. The seminars are open to the public. Students and faculty are encouraged to attend.



**Location:** Seminars are held on Wednesdays from 11:00a-12:00p in EN 239

### Schedule:

- Wed. February 4: David Harvatin, "Differential QAM "
- Wed. February 11: Dr. Mark Wickert, "A Real-Time DSP Overview"
- Wed. February 18: TBD
- Wed. February 25: TBD
- Wed. March 4: Mark Petzold, "Serial Concatenated Convolutional Codes and Multicarrier Modulation"
- Wed. March 11: Dr. Rodger Ziemer, "TBD"
- Wed. March 18: TBD
- Wed. March 25: Spring Break
- Wed. April 1: Adrian Boariu, "Optimum Linear Multi-User CDMA Receivers"\*\*
- Wed. April 8: Dr. Simona Halunga, "Tracking Loops in Fading Environments"
- Wed. April 15: TBD
- Wed. April 22: Peter Hofstetter, "The Study of a DSP-Based Wireless pi/M-MDPSK Modem using Quasi-Analytic Simulation Techniques"
- Wed. April 29: Mark Petzold, "C++ and OOP For Simulation of Communications Systems"
- Wed May 6: TBD
- Wed. May 13: No Seminar, Finals

\* Denotes MSEE. thesis topic in final stages.

\*\* Denotes Ph.D. dissertation topic in final stages.

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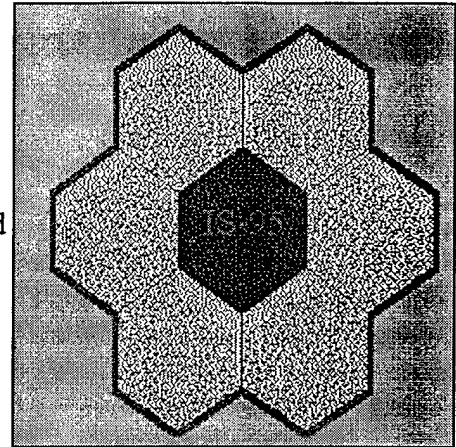
[wickert@signal.uccs.edu](mailto:wickert@signal.uccs.edu)

*This page was last updated January 28, 1998.*

# Graduate Research Seminars

## Fall Semester 1997

The following seminars will be presented by graduate students and faculty members in room EN 177 in the Engineering and Applied Science Building on the UCCS campus. Ongoing research and dissertation topics in the fields of *communications* and *signal processing* will be discussed. The seminars are open to the public. Students and faculty are encouraged to attend.



**Location:** Seminars are held on Wednesdays from 11:00a-12:00p in EN 177

### Schedule:

- Wed. Sept. 10: Dr. Mark Wickert, "Hardware Implementation Loss for a pi/M-MDPSK Modem"
- Wed. Sept. 17: Vankatesh Sunkad, "Design and Analysis of Efficient Cellular Systems for Voice and Data"\*\*\*
- Wed. Sept. 24: Dr. Rodger Ziemer, "Modulation and Coding Considerations for Third Generation PCS"
- Wed. Oct. 1: Adrian Boariu, "CDMA Joint/Multi-User Detection in Multipath Channels"\*\*\*
- Wed. Oct. 8: Dr. Mark Wickert, "Free-Space and Guided Wave Optical Communications Technology"
- Wed. Oct. 15: David Harvatin, "Recent Developments in Coded OFDM"
- Wed. Oct. 22: **Special Visitor**, Prof. Vasile Buzuloiu, University POLITEKNICA, Bucharest, "Fast and Precise Recovery of a Pulse From a Few Samples"
- Wed. Oct. 29: Thad Welch, "Performance of DSSS/MCM Systems in Fast Fading Channels"\*\*\*
- Wed. Nov 5: No Seminar - Milcom '97
- Wed. Nov. 12: Dr. Simona Halunga, "Effects of Multipath on the Unlock Behavior of DSSS Code Tracking Loops"
- Wed. Nov. 19: Dr. Rodger Ziemer, "Resource Management for Third Generation PCS"
- Wed. Nov. 26: No Seminar, Thanksgiving Vacation
- Wed. Dec. 3: Mark Petzold, "Turbo Codes for PSC in Fading Channels"\*\*\*
- Wed Dec. 10: Peter Hofstetter, Quasi-Analytic Simulation Techniques for pi/M-MDPSK Modems in a Mobile Channel"
- Wed. Dec. 17: No Seminar, Finals

\* Denotes MSEE. thesis topic in final stages.

\*\* Denotes Ph.D. dissertation topic in final stages.

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[wickert@signal.uccs.edu](mailto:wickert@signal.uccs.edu)

*This page was last updated October 17, 1997.*

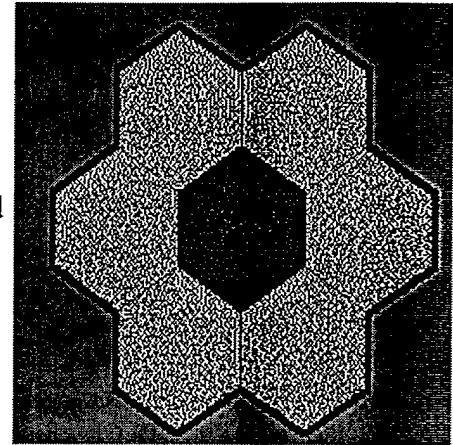
**COMMUNICATIONS AND SIGNAL PROCESSING SEMINARS**  
**SPRING SEMESTER, 1997**  
**Wednesdays at 11:00**  
**Room EN177**

Jan. 22	Dr. Rodger Ziemer, "Digital Receivers for Satellite and Cable TV"
Jan. 29	No seminar
Feb. 5	Dr. Mark Wickert, Title TBA
Feb. 12	Vankatesh Sunkad, "Design and Analysis of Efficient Cellular Systems for Voice and Data -III"
Feb. 19	Thad Welch, "Performance of DSSS/MCM Systems in Doppler Spread Channels"
Feb. 26	Mark Petzold, "Turbo Codes - FFT Schemes for Constituent Codes"
Mar. 5	Thanh Van Truong, "Rate-Line Detection Using Higher-Order Spectra - V"
Mar. 12	Keith Kressin, "Vector Quantization of Wavelet Coefficients"
Mar. 19	Mark Jones, "Repetition Coded DPSK for Faded Mobile Communications - VI"
Mar. 26	Spring Break
Apr. 2	Dr. Joshua Alspector, "User Model for Internet Services"
Apr. 10 - 12:30	Dr. Paul Cotae, "Digital Beamforming in Wireless Communications" (note day and time change)
Apr. 16	Dr. William Lindsey, USC, TBA
Apr. 23	David Harvatin, "OFDM Performance with Coding in Delay/Doppler Spread Channels"
Apr. 30	Adrian Boariu, "CDMA Decorrelation Receivers - II"
May 7	No seminar - Vehicular Technology Conference

# Graduate Research Seminars

## Fall Semester 1996

The following seminars will be presented by graduate students and faculty members in room EN 239 in the Engineering and Applied Science Building on the UCCS campus. Ongoing research and dissertation topics in the fields of communications and signal processing will be discussed. The seminars are open to the public. Students and faculty are encouraged to attend. Schedule for Fall Semester, 1996.



**Location:** Seminars are held on Wednesday at 11:00 AM in EN 239

### Schedule:

- Sept. 4: Mike Ionescu, "Wavelet Spread Spectrum System Design and Performance"\*
- Sept. 11: Dr. Mark Wickert, "Wireless LAN Standards - 802.11 and Hiperlan"
- Sept. 18: Dr. Rodger Ziemer, "Report on the Navy Workshop on Wireless Networks"
- Sept. 25: Vankatesh Sunkad, "Design and Analysis of Efficient Cellular Systems for Voice and Data -II"
- Oct. 2: Mark Jones, "Repetition Coded DPSK for Faded Mobile Communications - V"\*
- Oct. 9: Thad Welch, "Spread Signature CDMA"
- Oct. 16: Thanh Van Truong, "Rate-Line Detection Using Higher-Order Spectra - IV"\*
- Oct. 25: Mark Petzold, "Iterative Decoding for Turbo Codes" (note change of day)
- Oct. 30: Keith Kressin, "Wavelet Image Compression"
- Nov. 6: David Harvatin, "OFDM Simulation in Delay/Doppler Spread Channels"
- Nov. 13: Adrian Boariu, "CDMA Decorrelation Receivers"
- Nov. 20: Dr. C.-J. Wang, "Mobile Computing"
- Dec. 4: Alex Kolcz, "Pattern Recognition in Handwritten Archives"
- Dec. 11: Dr. Joshua Alspector/Peter Dumitru, "Neural Network Topics"
- Dec. 18: Dr. Paul Cotae, "Sampling and Quantization Effects in a Coherent Correlator for C/A Code GPS Signals"

\* Denotes Ph.D. dissertation topic in final stages.

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[wickert@signal.uccs.edu](mailto:wickert@signal.uccs.edu)

*This page was last updated September 4, 1996*

**University of Colorado at Colorado Springs**  
**Department of Electrical and Computer Engineering**  
***Communications and Signal Processing Seminars***

The following seminars will be presented by graduate students and faculty members in room EN 239 in the Engineering and Applied Science Building on the UCCS campus. Ongoing research and dissertation topics in the fields of communications and signal processing will be discussed. The seminars are open to the public. Students and faculty are encouraged to attend.

**Schedule for Summer Session, 1996**  
**Seminars are held on Tuesdays at 11:00 AM in EN 239**

June 18	Mark Petzold, "An Overview of Turbo Codes" (Note: the meeting time for this seminar is 2:00; all others are at 11:00.)
June 25	Dr. Rodger Ziemer, "An Overview of Research in Signal Processing/Communications in ECE at UCCS"
July 2	Mark Jones, "Repeat Differential Phase-Shift Keying"*
July 9	Dr. Mark Wickert, "An Overview of Hot Topics at ICC"
July 16	Mike Ionescu, "SNR Degradation with Multiple Users in Wavelet Spread-Spectrum Communications"*
July 23	Dave Horvatin, "Simulation of OFDM in Delay/Doppler Spread Fading Channels"
July 30	Thanh Truong, "Eigenanalysis Methods Using Cumulant Projections for Harmonic Retrieval"*
Aug. 6	Dr. Mike J. Ketseoglou, Omnipoint Corp., Topic To Be Announced

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\*Denotes Ph. D. dissertation topic in final stages.

**University of Colorado at Colorado Springs**  
**Department of Electrical and Computer Engineering**  
***Communications and Signal Processing Seminars***

The following seminars will be presented by graduate students and faculty members in room EN 187 in the Engineering and Applied Science Building on the UCCS campus. Ongoing research and dissertation topics in the fields of communications and signal processing will be discussed. The seminars are open to the public. Students and faculty are encouraged to attend.

**Schedule for Spring Semester, 1996**  
**Seminars are held on Wednesdays at 11:00 AM in EN 187**

Jan. 24	Dr. Rodger Ziemer, "Physical Layer Design Using Coded OFDM for Wireless LANs"
Jan. 31	Mark A. Jones, "Repetition Coded DPSK for Faded Mobile Communications - IV"
Feb. 7	Venkatesh Sunkad, "Design and Analysis of Efficient Cellular Systems for Voice and Data"
Feb. 14	Mike Ionescu, "Wavelet Decomposition of Random Signals: Application to Multipath Channel Probing, III" (meet in EN134)
Feb. 21	Mark Petzold, "VA Decoding of Punctured Codes - Bounds and Simulation"
Feb. 28	Thanh Van Truong, "Rate-Line Detection Using Higher-Order Spectra, III"
Mar. 6	Dr. Mark Wickert/Chad Tanner, "ATM Wireless Networks"
Mar. 13	Dr. Paul Cotae, "Ring Convolutional Encoded CPM"
Mar. 20	Dr. Rodger Ziemer/D. Horvatin, "Multicarrier Modulation Performance in Delay/Doppler Spread Channels"
Apr. 3	Dr. Mark Wickert/Bill Sward, "Gaussian Minimum-Shift Keying Performance in Cellular Environments"
Apr. 10	Mike Ionescu, "Wavelet Decomposition of Random Signals: Application to Multipath Channel Probing, IV"
Apr. 17	Thad Welch "Performance of Spread Spectrum MCM in Fading"
Apr. 24	Venkatesh Sunkad, "Design and Analysis of Efficient Cellular Systems for Voice and Data, II"
May 8	Dr. Josh Alspector, "Neural Network Applications to Communications"



# **COMMUNICATIONS AND SIGNAL PROCESSING SEMINARS**

**FALL SEMESTER, 1995**

**Wednesdays at 11:00**

**Room EN239**

- |          |  |
|----------|--|
| Sept. 13 | Dr. Rodger Ziemer, "Multicarrier Modulation"   |
| Sept. 20 | Dr. Mark Wickert, "Limiter-Discriminator Detected GMSK with FM AMPS Interference in a Land Mobile Channel" |
| Oct. 4   | Dr. Paul Cota, "The Performance of Binary QPRS Modulation Schemes"   |
| Oct. 11  | Dr. Rodger Ziemer, "Multicarrier-Modulated Spread-Spectrum Systems"  |
| Oct. 25  | Thad Welch, "A Monte-Carlo Simulation of AWGN Pulse Jamming Effectiveness on a Direct Sequence SS System"  |
| Nov. 1   | Mark Jones, "Repetition Coded DPSK for Faded Mobile Communications"  |
| Nov. 8   | Thanh Van Truong, "Rate-Line Detection Using Higher-Order Spectra"   |
| Nov. 15  | Mark Petzold, "Punctured Convolutional Code Performance"   |
| Nov. 22  | Cristian Rezenau, "Joint Parameter Estimation for Burst DS SS Transmission"                                |
| Dec. 6   | Doug DeBoer, "Shaped Modulation in Noisy Fading Channels"  |

**University of Colorado at Colorado Springs**  
**Department of Electrical and Computer Engineering**  
***Communications and Signal Processing Seminars***

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**Schedule for Spring Semester, 1995**  
**Seminars are held on Wednesdays at 11:00 AM in EN 239**

January 25	Dr. Mark Wickert, "SystemView™ Description and Applications"
February 8	Mark A. Jones, "Repetition Coded DPSK for Faded Mobile Communications - I"
February 15	Cristian Rezeanu, "Maximum Likelihood Joint Code Phase, Carrier Phase, and Data Sequence Estimation."
February 22	Dr. Cristian Toma, "High-Level Synthesis of Digital Signal Processors"
March 1	Dr. Paul Cotae, "Pulse and Spectrum Shaping in Constant Envelope Modulation"
March 8	Mike Ionescu, "Wavelet Applications to Signal Reception in Multipath"
March 15	Thranh Van Truong, "Spectral Line Detection Using Higher-Order Spectra. Part II: Spectral Line Detection by the Cyclostationary Approach"
April 5	Dr. Paul Cotae, "Efficient Trellis Coded Modulation Schemes"
April 12	Dr. Rodger Ziemer, "Rake Reception in Multipath with Punctured Convolutional Encoding"
April 19	Venkatesh Sunkad, "Handoffs in Mobile Radio Communications"
April 26	Mark A. Jones, "Repetition Coded DPSK for Faded Mobile Communications - II"
May 2	Dr. Armando Montelvo, "Colored Noise and Its Effects on Trellis Coded Modulation Schemes and Partial Response Systems"

## References

1. C. M. Barnhart and R. E. Ziemer, "Topological Analysis of Satellite-Based Distributed Sensor Networks," *IEEE Trans. on Systems, Man, and Cybernetics*, Vol. 21, pp. 1060-1070, Sept. 1991 (special issue on Distributed Sensor Networks).
2. M. A. Wickert and R. L. Turcotte, "Probability of Error Analysis for FHSS/CDMA Communications in the Presence of Rayleigh or Single Term Rician Fading," *IEEE Journ. on Sel. Areas in Commun.*, Vol. 10, pp. 523-534, Apr. 1992.
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# REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)

2. REPORT DATE  
14 August 1998

3. REPORT TYPE AND DATES COVERED  
Final: 1 July 95 - 30 June 98

4. TITLE AND SUBTITLE  
*Satellite/Terrestrial Communication Network Evaluation  
With Computer-Aided Workstation Tools*

5. FUNDING NUMBERS  
G N00014-920J01761/P00004  
R&T No. S400012srb11

6. AUTHOR(S)  
Roger E. Ziemer

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)  
University of Colorado at Colorado Springs  
Electrical and Computer Engineering Department

8. PERFORMING ORGANIZATION  
REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)  
Office of Naval Research  
800 Quincy Street, ONR 313  
Arlington, VA 22217-5660 (Dr. R. N. Madan)

10. SPONSORING / MONITORING  
AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

a. DISTRIBUTION / AVAILABILITY STATEMENT

Supersedes all previous reports for this grant

12. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

*Research has been performed on satellite and terrestrial networks. The work was broken down into five tasks: Network, channel, and modem models; Investigation of decentralized routing/restoration algorithms under dynamic network conditions; Characterization of throughput and error performance; Applicability of various adaptive and diversity approaches; Study connectivity and flow control strategies appropriate for networks of networks with mobile nodes. The output of the grant is in the form of several publications in national and international conference proceedings, archival journals, and masters and Ph. D. theses. Several specialized pieces of software were developed and are briefly described in Appendix A.*

14. SUBJECT TERMS  
Satellite communications; terrestrial communications;  
computer-aided tools; network evaluation

15. NUMBER OF PAGES 22

16. PRICE CODE

17. SECURITY CLASSIFICATION  
OF REPORT  
Unclassified

18. SECURITY CLASSIFICATION  
OF THIS PAGE  
Unclassified

19. SECURITY CLASSIFICATION  
OF ABSTRACT  
Unclassified

20. LIMITATION OF ABSTRACT  
None